

Name: \_\_\_\_\_ Section: \_\_\_\_\_ TA: Celeste / Sarah / Ken

ATM S 101 MIDTERM EXAM 1.  
Winter 2004

**Limit your answers to the spaces provided.**

1. Considering that the outgassing from the volcanoes contained very little nitrogen, then **why** is the present day composition of the atmosphere dominated by it? (Maximum 4 lines)

Volcanic outgassing released primarily water vapor and carbon dioxide, as well as trace amounts of nitrogen. The water vapor condensed into clouds and rain and formed the oceans. The carbon dioxide dissolved into the oceans and formed rocks. Since nitrogen is unreactive in the atmosphere, it remained and built up over time. With the water vapor and carbon dioxide leaving the atmosphere, the relative percentage of nitrogen increased to its present level.

2. **Indicate** which has more heat and **explain briefly** (maximum 2 lines each) why:

- a) 2 cups of water at 30°C, 1 cup of water at 30°C, or they both contain the same amount of heat.

The two cups of water contains more heat. Since all the water is at the same temperature, it all has the same average kinetic energy. However, the 2 cups has more molecules, and more molecules with the same average energy results in more total kinetic energy, or heat. Another way to think of this is that the heat required to bring the temperature to 30 degrees C is equal to mass\*specific heat \* change in temperature, so more mass implies more heat to reach a given temperature.

- b) 1 kg of water vapor at 100°C, 1 kg of liquid water at 100°C, or they both contain the same amount of heat.

Water vapor contains more heat or energy. This extra heat is what we called latent heat, which is needed to change the phase of water from liquid to gas.

3. In general cloudy nights tend to be warmer than clear nights. **Explain why this should be the case.** (Maximum 2 lines)

Clouds are composed of water vapor and droplets. They absorb the IR radiation emitted by the surface during the night and radiate back some of it, keeping the surface warmer than otherwise.

NOTE: To emit or radiate is not the same as to reflect.

4. **List three reasons** that may make the maritime and continental seasonal temperature ranges different.

The maritime climate experiences less extreme seasonal variation than the continental climate due to differences in:

- a) Specific heat of water is greater than specific heat of land, which means you need more energy to change the temperature of water than of land
- b) More mass of ocean is heated (thicker layer), meaning more energy is needed to change its temperature.
- c) Evaporation over the ocean uses some of the energy, so less is available for warming.

An effect that works in the opposite direction is the albedo difference: the land reflects more sunlight back to space while the ocean absorbs a higher percentage.

5. **Sketch** the vertical temperature profile of the atmosphere and **indicate** the different layers and the boundaries between them.

See figure 1.7 (p. 9) in the textbook.

NOTES:

- The height values were not taken into consideration except for the height of the tropopause (somewhere between 10 and 20 km would have been ok).
- The (incorrect) inclusion of the exosphere was not taken into consideration, although it shouldn't appear in this plot (it is found further up).

6.

- a) Suppose that the Earth receives 200 units of solar radiation and 60 of these units are reflected back to space. **How many units** should the Earth radiate to space to prevent it from warming up?

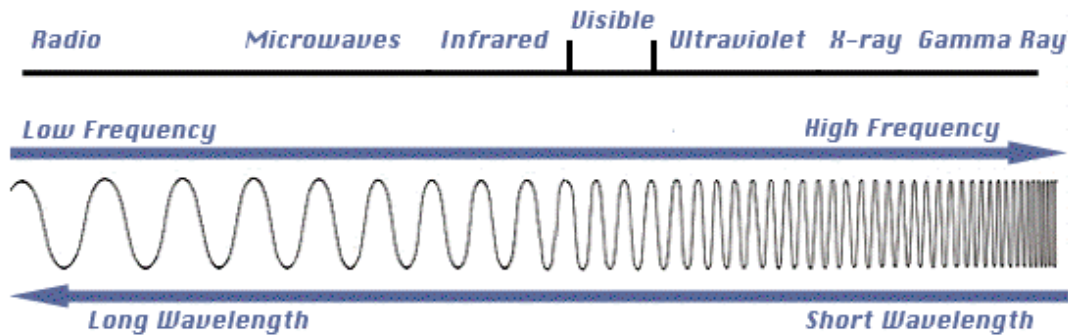
140 units. The earth receives 200 units of solar radiation at the top of the atmosphere. Sixty of these are reflected without being absorbed. Therefore, the earth will absorb 140 units of radiation. To maintain a constant temperature, the earth must radiate the same amount of energy as it receives, i.e. 140 units.

- b) In **what part of the electromagnetic spectrum** does the Earth radiate this energy?

Infrared

- c) Would the Earth have a higher or lower temperature than an object whose peak emission is in the microwave region? **Explain.** (Hint: The following figure may help you) (Maximum 2 lines)

The earth has a higher temperature than an object whose peak emission is in the microwave part of the electromagnetic spectrum. Assuming the earth is a blackbody, we can use Wien's law to relate the temperature of the earth to the wavelength of its peak emission (infrared). Wien's law states that the wavelength of an object's peak emission is inversely proportional to the temperature of the object. As the wavelength of peak emission increases, the temperature of the object decreases. Thus, an object emitting microwaves (which have a longer wavelength than infrared) has a lower temperature than an object emitting in the infrared.



7. **How** does evaporation cool the ground? (Maximum 3 lines)

Evaporation is the change in phase of a liquid to a gas (e.g. liquid water to water vapor). Energy is required to change the phase. This energy is called the "latent heat of evaporation." Water evaporating takes energy away from the surface (land or ocean). The temperature of the surface then decreases as the surface loses energy to the water vapor.

8. **Venusian climate**

THIS QUESTION WAS NOT GRADED BECAUSE IT REQUIRED A CALCULATION, WHICH WAS SOMETHING YOU WERE TOLD NOT TO EXPECT..